Office of Oversight
Environment, Safety and Health

Report to the Secretary of Energy
on the Review of

Nuclear Criticality Safety at Key Department of Energy Facilities

March 2000

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Abbreviations Used in This Report

ANS	American Nuclear Society
ANSI	American National Standards Institute
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
LANL	Los Alamos National Laboratory
TA	Technical Area

OVERSIGHT

Executive Summary

Scope

In November 1999, the Deputy Secretary of Energy directed a series of actions to strengthen Department of Energy (DOE) nuclear criticality safety programs. As one of those actions, a team of criticality safety experts from DOE Headquarters and the field conducted a high-level review of operational criticality safety controls at five DOE sites. The review, led by the Office of Oversight within the DOE Office of Environment, Safety and Health, focused on DOE facilities that process solutions of fissile materials because solutions represent the greatest risk of a criticality accident. The reviews of the individual sites focused primarily on four key elements of the nuclear criticality safety program and examined institutional requirements and processes. The Oversight team observed field implementation of selected operations but did not perform a comprehensive review of implementation of requirements.

Results

The overall conclusion of the Oversight review is that there are no imminent criticality safety hazards at the DOE facilities reviewed. DOE has adopted national consensus criticality standards that are specifically designed to reduce the risk of a criticality accident. The standards provide a mechanism for implementing the DOE integrated safety management policy in the nuclear criticality safety arena. The existence and application of these standards represent an important distinction between DOE sites and a facility in Tokai-mura, Japan, that experienced a widely publicized criticality accident on September 30, 1999. The lack of similar standards was one of the contributing factors in the Tokai-mura criticality accident.

While the Oversight team found weaknesses in the aspects of nuclear criticality safety programs that were the subject of this review, some aspects of DOE criticality safety programs are notably effective. For example, Los Alamos National Laboratory (LANL) demonstrates proper implementation of the national consensus criticality standards. In addition, the interaction between nuclear criticality safety staff and the operations personnel at LANL was particularly effective at the LANL facility reviewed (Technical Area 55 Building PF-4).

The most significant weaknesses were identified at the Y-12 Plant. Although no imminent hazards were identified, two safety issues—areas where provisions of DOE orders and national consensus criticality standards were not met—were noted at the Y-12 Plant. One safety issue involved inadequate control of movements of fissile nuclear materials. The second involved insufficient site reviews of operations to ensure compliance with nuclear criticality safety requirements. These two issues require a formal corrective action plan in accordance with DOE orders (i.e., DOE Order 414.1A, *Quality Assurance*). Other identified weaknesses were less significant but still warrant management attention and corrective actions.

There are several weaknesses that were evident at most or all of the five sites reviewed. The DOE field offices do not have the experienced nuclear criticality safety practitioners or the guidance needed to implement line management oversight of contractor programs as intended by DOE policy (DOE Policy 450.5, *Line Environment, Safety and Health Oversight*). Similarly, there are weaknesses in contractor line management oversight of nuclear criticality safety programs and its implementation. For example, some sites do not apply the necessary technical expertise on self-assessments and do not have sufficient processes (e.g., committees with a clear charter) to provide feedback to contractor management, as required by the standards and integrated safety management principles. In addition, contractor line management does not uniformly ensure that operators participate in the development and implementation of nuclear criticality safety controls, ensure that operators understand the basis for controls, and encourage interaction between criticality safety

professionals and operators. Some aspects of DOE Order 420.1, *Facility Safety*, conflict with the national consensus criticality standards in the area of developing criticality controls, creating confusion in the field about how to best develop effective controls. Finally, DOE has not issued requirements for training and qualifying criticality safety professionals. DOE committed to such requirements in its implementation plan for Defense Nuclear Facilities Safety Board Recommendation 97-2 but has not met the established milestone in this area.

Opportunities for Improvement

Additional attention is needed to ensure that DOE programs continue to improve through the application of the national consensus criticality standards and integrated safety management principles. This summary report identifies five opportunities to enhance DOE criticality safety programs throughout DOE:

- Ensure that criticality controls and their technical bases are understood.
- Ensure rigorous adherence to procedures and controls.
- Improve feedback and improvement processes.
- Revise DOE orders and guidance to remove inconsistencies with national consensus standards and promulgate needed requirements.
- Strengthen DOE field office nuclear criticality safety programs.

The opportunities for improvement above complement the site-specific opportunities for improvement that the Oversight team provided to the five DOE field offices that were reviewed as part of this effort.

Assessment reports for each of the five sites will be provided to DOE senior management and to the responsible operations office managers. These reports will provide more detailed results of the assessment at each site.

1.0 Introduction

As one part of a broader initiative to enhance Department of Energy (DOE) nuclear criticality safety programs, the Deputy Secretary of Energy directed the Office of Environment, Safety and Health (EH) Office of Oversight to review selected aspects of the nuclear criticality safety programs at five DOE sites. Consistent with the Deputy Secretary's direction, Oversight developed this summary report for the Secretary of Energy that includes: (1) an identification of any immediate problems and related corrective actions, and (2) an assessment of whether the operations and criticality safety risks are well understood, analyzed, and controlled.

Background

As documented in the Deputy Secretary of Energy's November 3, 1999, memorandum entitled "Nuclear Criticality Self-Improvement Initiative," DOE has ongoing initiatives to strengthen the DOE nuclear criticality safety program. Several DOE initiatives are described in the DOE Implementation Plans for Defense Nuclear Facilities Safety Board (DNFSB) Recommendations 94-1, 97-1, and 97-2. These implementation plans address various DOE actions, including efforts to stabilize fissile materials for safe long-term storage, enhance DOE's analytical techniques (including experiments to enhance the technical basis for computer codes used in nuclear criticality safety analyses), develop methods to attract and retain criticality safety professionals, and ensure adequate nuclear criticality safety training facilities for criticality safety practitioners.

In addition, an August 1999 DOE workshop for senior Federal and contractor managers, "Your Mission and Nuclear Criticality Safety," identified a series of specific actions needed to strengthen nuclear criticality safety. DOE has also taken actions to strengthen DOE oversight through implementation of a structured process (set out in DOE Order 414.1A, *Quality Assurance*) to ensure that independent oversight findings are effectively addressed and that corrective actions are verified to be effective.

In his November 3, 1999, memorandum, the Deputy Secretary directed a series of actions to support these ongoing initiatives. In addition to this Office of Oversight review of key facilities, these actions include self-assessments to be conducted by DOE field elements, Office of Oversight analysis of field element self-assessment results, development of performance metrics to be included in contract modifications, and an analysis of options for the relocation of the Los Alamos Critical Experiments Facility. The Deputy Secretary's memorandum specified that the results of this Oversight review of key facilities will be used by the DOE Nuclear Materials Council as one factor in developing the DOE framework for long-term fissile material stewardship.

Scope

As directed by the Deputy Secretary's memorandum, the Oversight reviews encompassed specific facilities at five DOE sites: the Oak Ridge Y-12 Plant, Los Alamos National Laboratory (LANL) Building PF-4 at Technical Area (TA) 55, Savannah River Site FB line facility and H-Area exterior tank storage, the Hanford Plutonium Finishing Plant, and Rocky Flats Building 371. Because the reviews were conducted on an expedited schedule, the Oversight team did not conduct a comprehensive, in-depth review of all elements of the site nuclear criticality safety programs. Rather, the Oversight team focused on four key nuclear criticality safety program elements as applied to selected fissile material operations. The review addressed the mandatory national consensus criticality safety standards developed by the American National Standards Institute (ANSI) and the American Nuclear Society (ANS) applicable to the four program elements . The Oversight team observed field implementation of selected operations but did not perform a comprehensive review of implementation of requirements.

The four key nuclear criticality safety elements reviewed were: criticality safety evaluations and controls, work control, change control, and line-management oversight. The criteria for each of these areas were provided by the Deputy Secretary and were derived from the national consensus standard ANSI/ANS-8.19, which is required by DOE Order 420.1, *Facility Safety*, and from DOE Policy 450.5, *Line Environment, Safety and Health Oversight*.

The fissile material operations that were reviewed were those involving processing, handling, and storage of solutions of fissile materials. Criticality accidents typically involve safety management system breakdowns impacting fissile solution processing. Of the 22 known criticality accidents involving fissile material processing, 21 have involved solutions, including the recently publicized accident in Tokai-mura, Japan.

The common causes of criticality accidents to date have been failure to perform a criticality safety evaluation for a process; undetected process and system changes; failure to develop, review, and approve operating procedures; absence of effective worker training; and failure to conform to established procedures and limits. No criticality accident has occurred as a result of a faulty calculation of reactivity, and no known criticality accident has involved storage or transport of fissile material.

The Oversight team also reviewed the Tokai-mura criticality accident to identify lessons learned from that accident that are pertinent to this review. As stated in the DOE report on the information exchange with the government of Japan, issued by the Secretary of Energy on February 29, 2000, applicable lessons from the Tokai-mura accident include:

- "Ensuring fundamental understanding of criticality and consequences of criticality accidents by all levels of involved personnel.

- "Ensuring controls are understood and rigorously followed for operations involving fissile materials. This includes understanding why the controls are important by the people performing the work.

- "Ensuring sufficient oversight and monitoring of operations involving fissile materials by supervisory, management, and regulatory personnel."

The Oversight team determined that these lessons learned from Tokai-mura are similar to lessons learned in previous criticality accidents and are already addressed by the national consensus standards, which were developed after consideration of previous criticality accidents worldwide. Consequently, the Oversight team determined that DOE sites should focus on effectively implementing the national consensus standards, which are based on consideration of a wide range of accidents, rather than focusing exclusively on the lessons learned from the Tokai-mura accident.

The Oversight team began its site reviews in November 1999 and completed them in January 2000. The seven-person team included nuclear criticality safety experts from DOE Headquarters and field offices. Following each of the individual site reviews, the Oversight team developed a site-specific report identifying positive attributes, safety issues (which require a formal corrective action plan, pursuant to DOE Order 414.1A. *Quality Assurance*), other weaknesses, and opportunities for improvement. The results of the site-specific reviews have been provided to the individual sites.

Fissile Material Operations at the Plutonium Finishing Plant

Organization of the Report

This report is organized to provide the Secretary of Energy with information he can use to improve nuclear criticality safety, including the information specified by the Deputy Secretary related to immediate problems and risks:

- Section 2 summarizes the reviews of the nuclear criticality safety programs at the five sites, including positive aspects and weaknesses.

- Section 3 presents the Oversight team's overall conclusions and assessment of immediate problems, including whether the operations and criticality safety risks are well understood, analyzed, and controlled.

- Section 4 identifies opportunities for improvement that apply to contractors at all DOE sites. These are based on enhancing implementation of the national consensus ANSI/ANS criticality standards.

- Section 5 draws on the results of the reviews of the five sites to identify opportunities for DOE to improve nuclear criticality safety through enhancements in policy and DOE-wide programs.

Appendix A presents information about the conduct of the site-specific reviews and the composition of the Oversight team that conducted the reviews.

2.0 Summary of Site-Specific Review Results

No imminent criticality safety hazards involving fissile solutions were identified at any of the five sites. The facilities reviewed have the program infrastructure, based on the ANSI/ANS-8 standards, in place to analyze the potential for criticality and to establish adequate criticality safety controls. Proper implementation of the nuclear criticality safety program elements, including the four elements assessed as part of this review, should ensure that the likelihood of a criticality accident remains low.

Some aspects of DOE criticality safety programs are notable. At LANL, the interaction of nuclear criticality safety staff (i.e., ESH-6 personnel) with the operations personnel (i.e., Nuclear Materials Technology staff) at TA-55 Building PF-4 is exemplary. Technicians are well trained and participate in the development of nuclear criticality safety controls, contingencies, and safe operating procedures. The nuclear criticality safety personnel are well qualified and knowledgeable of Building PF-4 equipment and processes, and they spend significant time interacting with operations personnel to develop practical and effective nuclear criticality safety controls and provide nuclear criticality safety guidance and training to operators. Other positive aspects of the DOE programs reviewed are shown in Table 1.

Most sites have ongoing initiatives that are designed to further enhance nuclear criticality safety. For example, Westinghouse Savannah River Company is developing a new approach for linking procedural nuclear safety controls directly to authorization basis documents by annotating nuclear safety controls within the procedures.

Although the risk of a criticality accident is low and several positive attributes were identified, the Oversight team identified weaknesses at all five sites. The most significant weaknesses (which are identified as safety issues in the site-specific report, consistent with Office of Oversight protocols) were identified at the Y-12 Plant. The facilities reviewed at the Y-12 Plant (Buildings 9212 and 9818, which have most

Table 1. Positive Aspects of Nuclear Criticality Safety Programs

- At Los Alamos National Laboratory, Rocky Flats and the Hanford facilities, operations management has established positions (e.g., criticality safety officers or criticality safety representatives) within the operating organizations to ensure that criticality safety requirements are effectively implemented. Such positions have been effective in providing liaison with the nuclear criticality safety staff, communicating with operators, and applying controls.
- At the Hanford Plutonium Finishing Plant, operators and supervisors demonstrated a good understanding of nuclear criticality safety controls and contingencies. The informal training sessions (brown bag lunches) are a practical and inexpensive way to provide continuous professional development for nuclear criticality safety personnel and criticality safety representatives.
- At Rocky Flats, the nuclear criticality safety staff's presence in the fissile material areas and interaction with operations personnel have improved operator understanding and implementation of nuclear criticality safety controls.
- DOE Savannah River Operations Office and Y-12 Site Office personnel spend significant time in the facilities, conduct periodic program assessments, and evaluate contractor performance against established performance criteria.

of the solutions at the Y-12 Plant) did not meet the provisions of DOE orders in two important areas: (1) movements of fissile nuclear materials between work locations were not adequately controlled, and (2) nuclear criticality safety assessments and reviews of operations were not sufficient to ensure that procedures were being followed and that the process configuration was maintained within established limits. Other weaknesses at the Y-12 Plant include failure to properly plan and execute work, complicated and confusing nuclear criticality safety requirements, lack of operator involvement in the nuclear criticality safety program, and weak feedback and continuous improvement processes.

The weaknesses at other sites were less significant but still warrant management attention and corrective actions. Examples of weaknesses evident at more than one DOE site include:

- Some criticality safety controls were complex and were difficult for operators to understand.

- At some sites, criticality safety professionals did not spend enough time interacting with the operations personnel to ensure that they were familiar with the facilities and processes and that they were providing useful information to operators.

- Some controls were developed without sufficient involvement by operations personnel, and operations personnel did not always understand the basis for nuclear criticality safety limits and controls.

- The technical basis for criticality safety evaluations was not always adequately documented.

- Some contractor nuclear criticality safety self-assessments and program reviews were not sufficiently comprehensive or conducted with experienced personnel familiar with the application of nuclear criticality safety practices.

- Most of the five DOE field offices reviewed do not have sufficient nuclear criticality safety technical expertise or the formalized program needed to provide adequate line management oversight of the contractors.

The site-specific reports provided to the five sites identify the specific weaknesses applicable to each site and include opportunities for improvement that site management should consider to enhance nuclear criticality safety. The two safety issues noted above for the Y-12 Plant require a formal corrective action plan in accordance with DOE Order 414.1A. Corrective actions for the other weaknesses identified in the site-specific reports should be specified in the site nuclear criticality safety self-assessment reports that are being developed as another element of the Deputy Secretary's direction in his November 3, 1999, memorandum.

Viewed collectively, some weaknesses evident at multiple sites indicate a need for improved policy or guidance and/or increased Headquarters attention. For example, DOE has developed guidance for training and qualifying contractor criticality safety staff in DOE-STD-1135-99, *Guidance for Nuclear Criticality Safety Engineer Training and Qualification*, but has not established a specific requirement to implement that guidance. In its Implementation Plan for DNFSB Recommendation 97-2, DOE included a commitment to establish a contractual requirement to implement the guidance. However, DOE is overdue on this commitment, and a requirement to implement the guidance is not yet in place.

As another example, DOE developed and distributed criteria at the workshop "Your Mission and Nuclear Criticality Safety." Those criteria were endorsed by DOE field element nuclear criticality safety programs and senior DOE management. However, the criteria have not been implemented at the sites reviewed, and there is no formal requirement to do so. In this instance, DOE senior management expectations are not being met. Section 5 lists opportunities for DOE Headquarters to improve policy and programs.

3.0 Conclusions and Assessment of Risks

The overall conclusion of the Oversight review is that no imminent criticality safety hazards involving fissile solutions exist at the five sites but that additional management attention is needed to ensure identified weaknesses are corrected. Proper implementation of the four elements of the nuclear criticality safety program should ensure that the risk of a criticality accident remains low at the facilities reviewed. Additional management attention is needed to improve implementation of the ANSI/ANS-8 standards, which also provide an effective means for implementing most aspects of DOE integrated safety management in nuclear criticality safety. The standards also encompass program improvements from the more recent nuclear criticality self-improvement initiative.

Criticality Safety Evaluations

The criticality safety hazards in the areas reviewed at the five sites are understood and properly analyzed. The controls that were developed as a result of the nuclear criticality safety evaluations are appropriate and, if properly implemented, are sufficient to prevent a criticality accident. The sites have systems that translate the nuclear criticality safety controls into directions to the operators (e.g., procedure steps and postings).

Although the criticality safety documents (such as criticality safety evaluations, procedure steps, and postings) provide the foundation for an effective nuclear criticality safety program, some aspects of the program require additional attention:

- Controls will be effective only if implemented as required by the operators at the working level. At some sites, the process for developing nuclear criticality safety documents is not easy to understand, and the resulting controls are not easy for operations personnel to implement.

- There is considerable variation in facilities' approaches to establishing and implementing controls. Most sites use self-contained criticality safety evaluations to document fissile material limits and the contingency analysis, whereas others use two separate safety basis documents to establish limits and contingencies. Some sites consider the criticality safety evaluations part of the authorization basis, but most do not.

- Because of inconsistencies with national consensus standards (ANSI/ANS-8.1), DOE Order 420.1 does not provide clear and effective direction related to criticality safety evaluations. Some sites place most of their emphasis on a definition of the double contingency principle contained in DOE Order 420.1 and focus on identifying "the two" controls identified in the order. This emphasis is not consistent with the intent and requirements of ANSI/ANS-8.1, which focuses on ensuring that the process remains subcritical under all normal and credible abnormal conditions. The DOE order's excessive emphasis on implementing "double contingency" through multiple controls on a single parameter can lead to deterioration of other important process controls that are not "the two" but that are nevertheless relied on in the supporting criticality safety evaluation. The requirements in the order also have the effect of promoting the use of DOE "checklists" to document "the two" while ignoring other controls credited in the criticality safety evaluation.

- The limited availability of fully qualified and experienced nuclear criticality safety staff who understand operations, including process upsets and credible events, is a longstanding concern that requires continued attention across DOE. (This issue is being addressed through a five-year plan under the DOE Implementation Plan for DNFSB

Recommendation 97-2.) Staff attrition, particularly at sites such as Rocky Flats, can exacerbate the recognized shortages of qualified and experienced nuclear criticality safety staff. Some sites rely heavily on subcontracted nuclear criticality safety staff, some of whom lack an adequate understanding of fissile material operations in the facilities they support. DOE has developed guidance (DOE-STD-1135-99) to ensure that nuclear criticality safety staff are familiar with facilities and operations before they develop criticality safety evaluations, but DOE is delinquent in its commitment to the DNFSB to incorporate the training and qualification standard as a contractual requirement. Consequently, most of the sites have no formalized process for ensuring that nuclear criticality safety staff are familiar with operations prior to performing work.

Operator Understanding of Controls

At several sites, operators did not adequately understand the technical basis for the criticality safety controls they are required to implement, partly because they do not participate sufficiently in developing the criticality safety evaluations. Worker involvement and feedback in developing and implementing criticality safety controls is an important tenet of integrated safety management. Furthermore, at several sites, criticality safety engineers rarely interact with operators and do not spend significant time in the fissile material handling and processing areas. Despite an existing interface between the criticality safety engineers and the process engineers, there was little or no operator involvement during the development of the criticality safety evaluations and controls.

The variation in operator knowledge and understanding of controls highlights the importance of the regular presence of criticality safety engineers in the process area, interacting with and informally educating the operators about the importance and meaning of the criticality safety controls and limits. At sites where operators demonstrated a good understanding of nuclear criticality safety controls (e.g., LANL and Rocky Flats), the operators participate in the development of controls and know why the controls are in place. Conversely, at sites where criticality engineers did not spend significant time interacting with operators, the operators did not display a good knowledge of the technical basis for controls.

Several factors contribute to the insufficient coordination and interaction between nuclear criticality safety professionals and operating divisions. For example, because of the manner in which the nuclear criticality safety program is funded, criticality safety engineers often are required to work only on specific projects; there is no opportunity or funding for general activities, such as interaction with operators. In addition, line management and nuclear criticality safety department supervisors have not always established clear expectations for such interactions. To ensure effective and frequent interactions, criticality safety engineers need to spend a significant portion of their time in the process area interacting informally with operators while performing audits, participating in operator on-the-job-training, and becoming familiar with the fissile material operations in that area. Such interactions are unlikely to occur unless line management establishes clear expectations and ensures that appropriate direction and support (including funding mechanisms) are in place to allow frequent interaction.

Work Planning and Control

Processes for planning and controlling work varied in effectiveness. As a positive feature, some sites (e.g., Hanford, Rocky Flats, and LANL) have implemented criticality safety officer positions in the operating organizations. The criticality safety officers perform many useful administrative and liaison functions, such as preparing postings, attending pre-job briefings, and interacting daily with operators. These functions allow operations personnel to "own" the nuclear criticality safety program on the basis of technical data, input, and advice obtained from the nuclear criticality safety staff. Some important work planning and control elements have been implemented at all sites reviewed, such as pre-job briefings and facility configuration change control. However, weaknesses were identified at several sites in the document control practices related to procedures and nuclear criticality safety postings and evaluations. Work planning and control practices were deficient at the Y-12 Plant, resulting in numerous violations of nuclear criticality safety requirements.

Line Management Oversight

Another important factor in assessing the adequacy of the site's understanding of operations and criticality

risks is the adequacy of line management (both contractor and DOE) nuclear criticality safety oversight processes that provide feedback for continuous improvement. Rigorous self-assessments and feedback are required by the ANSI/ANS 8.19 standard and by DOE Policy 450.5. Further, effective feedback and continuous improvement constitute a fundamental component of the integrated safety management program.

DOE line management oversight of nuclear criticality safety programs lacks depth and consistency throughout the DOE complex, ranging from adequate to nonexistent. Most field offices have not implemented nuclear criticality safety oversight programs in accord with the criteria disseminated at the workshop "Your Mission and Nuclear Criticality Safety." For example, most DOE nuclear criticality safety programs do not have documented assessment plans or performance metrics. An additional factor contributing to deficiencies in DOE field office nuclear criticality safety programs is that DOE has not promulgated implementing requirements for developing DOE line management oversight of nuclear criticality safety. In addition, the capabilities of the field office nuclear criticality safety program managers vary widely.

There is a serious shortage of nuclear criticality safety staff in the field offices who have technical experience in criticality safety. Most of the nuclear criticality safety personnel at DOE field offices have not had hands-on experience as criticality safety engineers in nuclear processing facilities. Most field office nuclear criticality safety positions are limited to GS-12 or GS-13 levels. The proper implementation of nuclear criticality safety national consensus standards (required by DOE Order 420.1) can be accomplished only if there is a strong, experienced nuclear criticality safety presence in the DOE field office.

Problems with field element line oversight were most notable at LANL. The Albuquerque Operations Office and its Los Alamos Area Office are not providing effective line management oversight of the LANL nuclear criticality safety programs and are not meeting the expectations of DOE Policy 450.5, *Line Oversight of Environment, Safety, and Health*. The Los Alamos Area Office does not have a qualified nuclear criticality safety subject matter expert, and neither the Albuquerque Operations Office nor the Los Alamos Area Office has an ongoing program for nuclear criticality safety assessments. Although the LANL Building PF-4 nuclear criticality safety program is currently effective, the programs at other LANL facilities may not be as well implemented; Building PF-4 benefits from a relatively mature integrated safety management program and strong line management support. Thus, DOE line management may not receive the information it needs because of the absence of effective feedback from line staff.

With respect to contractor line management oversight, each of the site contractors has some form of a line management self-assessment and feedback process in its criticality safety program. However, the effectiveness of these activities varies. For example, LANL has an effective Criticality Safety Committee that reports to the Director of the Laboratory and is chartered to conduct annual appraisals of all operations that involve significant quantities of fissile materials. The committee oversees the annual assessments and ensures that issues are addressed and tracked to closure. This committee also provides technical advice to the Laboratory Director on criticality safety issues to enable sound decisions. However, some contractors (including the contractors at the Y-12 Plant and Hanford) have weak nuclear criticality safety self-assessment programs and do not make effective use of nuclear criticality safety committees/councils to provide input to senior management.

All five sites would benefit from self-assessment processes that systematically review the nuclear criticality safety program according to the ANSI/ANS-8.19 criteria. A major part of the Department's Criticality Safety Improvement Initiative is the implementation of effective contractor nuclear criticality safety self-assessments. Because of weaknesses in the self-assessment programs, senior contractor management may not be getting all the information they need in order to recognize weaknesses, make improvements, and ensure that corrective actions are effective.

4.0 DOE Site Opportunities for Improvement

At the DOE facilities reviewed, there was no evidence of major breakdowns in the criticality safety programs such as those that resulted in the criticality event at Tokai-mura, Japan. As discussed previously, the sites that were reviewed have established adequate controls, as well as programs (e.g., conduct of operations) designed to ensure that fissile material handlers and operators adhere to the established controls. While none of the identified weaknesses poses imminent criticality safety hazards, continued attention is needed to ensure that those weaknesses are addressed and that performance does not deteriorate.

This section identifies three general opportunities for improvement and related actions that DOE sites should consider to enhance their nuclear criticality safety programs. While some sites may already have effective practices in some of these areas, these opportunities for improvement are generally applicable to all five sites included in this Oversight review, as well as to other DOE sites that were not reviewed.

1. Ensure that criticality controls and their technical bases are understood.

In general, operators do not uniformly participate in the development and implementation of nuclear criticality safety controls, understand the basis for nuclear criticality safety controls, or interact with criticality safety engineers on a routine basis. Line management does not ensure that criticality safety engineers spend a large portion of their time in the fissile material areas learning the operations, performing on-the-job-training with operators, holding informal discussions, and conducting nuclear criticality safety audits and inspections alongside operators to improve operator knowledge and understanding. Actions to improve operators' understanding of the bases for criticality controls and their participation in implementing the nuclear criticality safety program include:

- Ensure frequent and effective interactions between nuclear criticality safety staff and operations personnel in accordance with ANSI/ANS 8.1 and 8.19 and DOE-STD-1135-99, *Guidance for Nuclear Criticality Safety Engineer Training and Qualification*, including "on-the-floor" assessments and on-the-job training of operators.

- Perform "on-the-floor" walkdowns of procedures, operations, and criticality safety evaluations and controls by teams of operators and nuclear criticality safety professionals to ensure that actual conditions meet established nuclear criticality safety requirements. Walkdowns should cover all areas on at least an annual basis.

- Ensure that nuclear criticality safety professionals who are thoroughly familiar with the facility and operations are accessible to answer questions from operators and respond to operations needs on a priority basis.

- Ensure that operations personnel, including operators and fissile material handlers, are involved in developing nuclear criticality safety evaluations and controls and that they understand the underlying basis for established controls and limits.

- Ensure that nuclear criticality safety staff understand facility operations, including process upsets and credible events, so that they can provide effective advice and develop practical controls to provide an adequate margin of safety against any single credible contingency.

- Promote contractor line management "ownership" of nuclear criticality safety program implementation by utilizing criticality safety officers within the operating groups to perform certain nuclear criticality

safety functions. Elements of the LANL, Rocky Flats, and Hanford Plutonium Finishing Plant nuclear criticality safety programs can be used to benchmark good practices in this area.

2. Ensure rigorous adherence to procedures and controls.

In the interviews conducted during this review, managers, supervisors, and workers generally indicated their understanding of the need to adhere to established nuclear criticality safety controls. However, the problems noted at the Y-12 Plant indicate that there are instances where controls are not fully and effectively implemented. Actions to enhance adherence to procedures and controls include:

- Continue to implement the DOE integrated safety management program to ensure that all work is performed safely.
- Emphasize and frequently reemphasize management expectations for effective conduct of operations, including procedure adherence and configuration control.
- Ensure that management expectations for stopping work when abnormal conditions are encountered and the priority of safety over production are communicated and understood at all levels of the workforce.

3. Improve feedback and improvement processes.

Some sites have weak nuclear criticality safety self-assessment programs and do not make effective use of nuclear criticality safety committees/councils to provide input to senior management. None of the five sites has a self-assessment process that systematically reviews the nuclear criticality safety program according to the criteria contained in ANSI/ANS-8.19. Suggested guidance was disseminated at the nuclear criticality safety workshop "Your Mission and Nuclear Criticality Safety." Because of the weaknesses in the self-assessment program, senior contractor management may not be getting all the information needed to recognize weaknesses, make improvements, and ensure that corrective actions are effective. Actions to enhance contractor management self-assessment include:

- Ensure that line management performs comprehensive self-assessments, tracks all findings to closure (including those from self-assessments, field element assessments, DNFSB reports, and Office of Oversight reports), and verifies the effectiveness of the corrective actions.
- Use a criticality safety committee, council, or advisory board consisting of technically qualified nuclear criticality safety personnel to provide advice to senior management, including periodic reviews of site programs such as operations, criticality safety documentation, and line organization self-assessments. This committee should periodically utilize external expertise. Best practices for criticality safety committees are exemplified by the LANL and Oak Ridge National Laboratory programs.
- Implement the self-assessment criteria based on ANSI/ANS-8.19 (disseminated at the workshop "Your Mission and Nuclear Criticality Safety") to ensure that all elements are assessed on an ongoing, periodic basis.

5.0 DOE Headquarters Opportunities for Improvement

Viewed collectively, several of the weaknesses evident at multiple sites indicate a need for improvement in policy or guidance and/or increased attention at Headquarters. For example, DOE has issued guidance for training and qualifying criticality safety staff but does not have a clear requirement to implement that guidance. In addition to site-specific opportunities included in the site-specific reports, the Oversight team identified several opportunities to enhance nuclear criticality safety programs across the complex. In some case (identified below), the effective practices evident at one or more of the DOE sites included in this Oversight review could serve as a benchmark for other DOE sites.

The DOE Nuclear Criticality Safety Program Management Team led by Defense Programs (DP-10) should take the lead in evaluating the opportunities for improvement listed below and determining an appropriate course of action. This Management Team should also take the lead in coordinating with the lead program secretarial offices and field elements as appropriate to ensure that enhancements are implemented at DOE sites.

1. Revise DOE orders and guidance to remove inconsistencies with national consensus standards, and promulgate needed requirements.

Actions to strengthen DOE orders, guidance, and requirements include:

- Revise DOE Order 420.1 to make the DOE application of the double contingency principle consistent with ANSI/ANS-8.1 and to eliminate the undue and potentially unsafe emphasis on implementing "double contingency" through two controls on a single parameter.

- Reexamine requirements and processes for including criticality safety evaluations in the authorization basis consistent with the ANSI/ANS-8 standards and best practices at LANL and Rocky Flats.

- Review and revise DOE-STD-3007-93 to clarify the purpose and content of criticality safety evaluations, emphasizing that they are stand-alone documents containing all the rationale and controls required to ensure subcritical operations.

- Establish a provision in DOE Order 420.1 that requires implementation of the training and qualification standard, DOE-STD-1135-99, for criticality safety staff.

2. Strengthen DOE field office nuclear criticality safety programs.

Actions to strengthen DOE field office programs include:

- Issue requirements for developing and implementing DOE line-management oversight of nuclear criticality safety programs considering the criteria issued at

Solution Storage Area at the Y-12 Plant

the workshop "Your Mission and Nuclear Criticality Safety."

- Provide guidance and expectations for having DOE field element nuclear criticality safety personnel spend sufficient time in the facilities to learn about the operations and equipment so that they have sufficient knowledge to perform effective line oversight.

- Monitor progress by DOE field elements to ensure that Federal personnel with nuclear criticality safety responsibilities are trained and qualified by December 2000 in accordance with the DOE commitment in the Implementation Plan for DNFSB Recommendation 97-2.

- Support activities that supplement the capability of DOE field elements, such as sharing technical staff or using the Criticality Safety Coordinating Team to share experience and lessons learned or to support periodic review of site programs.

- Promote hiring and retention of nuclear criticality safety staff who have technical experience as criticality safety engineers and encourage the use of such practices as hiring bonuses and excepted service.

APPENDIX A
REVIEW PROCESS AND TEAM COMPOSITION

Review Process

The review was conducted according to Office of Oversight protocols and procedures, including the validation of data throughout all stages of the process. The review included facility tours and interviews with DOE field office personnel and contractor personnel having responsibility for nuclear criticality safety, audits and assessments, work planning and control, configuration management, and authorization basis. The Oversight team reviewed a representative sample of operational criticality safety controls (e.g., criticality safety limits summarized in postings and stated in operating procedures), work control (e.g., other procedural and administrative controls governing normal work tasks, including maintenance, that affect criticality safety), change control, and audit/self-assessment practices. Selected criticality safety evaluations and other documents that formed the basis for these controls and practices were also reviewed.

In evaluating performance of the nuclear criticality safety programs, the Oversight team examined operational aspects of the safety management system in the areas specified by the Deputy Secretary: criticality safety evaluations and controls, work control, change control, and line management oversight. The evaluation criteria for these areas were derived from the national consensus standard ANSI/ANS-8.19 (which is required by DOE Order 420.1, *Facility Safety*) and DOE Policy 450.5, *Line Environment, Safety, and Health Oversight*.

The dates of the visits to the five sites are shown below. The composition of the Oversight team is set out on page 16.

SITE	DATES
Y-12 Plant	November 15-18, December 16, 1999
Los Alamos National Laboratory Building PF-4 at Technical Area 55	November 30 - December 2, 1999
Savannah River Site FB line facility and H-Area exterior tank storage	December 13-15, 1999
Hanford Plutonium Finishing Plant	January 10-12, 2000
Rocky Flats Building 371	January 18-20, 2000

Team Composition

The team membership, composition, and responsibilities are as follows:

Deputy Assistant Secretary for Oversight

S. David Stadler, Ph.D.

Associate Deputy Assistant Secretary for Oversight

Raymond Hardwick

Team Leader

Jerry McKamy, Ph.D.

Management Advisor to the Team

Ed Blackwood

Line Management Oversight Subgroup

Adolf Garcia
Jim Felty

Work and Change Control Subgroup

Bill Weaver
Gypsy Tweed

Criticality Safety Evaluations and Controls Subgroup

Steve Payne, Ph.D.
Ivon Fergus

Communications and Support

Cynthia D. Dorsey

Quality Review Board

Frank Russo
Raymond Hardwick
Thomas Davis
Thomas Staker